Effect of Minimum Tillage on Rice (*Oryza sativa L.*) Gold Fish (*Carassru auratus*) Integration

B.K.N.S. FERNANDO[1], B.P.A. JAYAWEERA[2], B. RANAWEERA[1] and U. EDIRISINGHE[3]

[1] Department of Horticulture and Landscape Gardening, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila. (NWP), Sri Lanka.

[2]Department of Livestock and Avian Sciences, Faculty of Livestock Fisheries and Nutrition, Wayamba University of Sri Lanka, Makandura, Gonawila. (NWP), Sri Lanka.

[3]Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Peradeniya.

ABSTRACT

Return to investment in rice farming is low. Therefore, goldfish fry were integrated into the rice fields to determine the feasibility of improving the return to investment from rice farming. This experiment was to investigate the effect of the minimum tillage to the performances of goldfish fry in paddy cultivation and to the paddy productivity with improved protective measures. For randomly selected three plots, minimum tillage treatment was applied and for the other plots normal tillage treatment was applied. Goldfish fry were stocked at 80 fry/m^2 in one season in four plots. Indoor tanks stocked at 80 fry/m^2 were taken as the control. Height, tiller number were measured weekly up to 50% flowering. Root, stem, leave dry weights and the weed density were recorded at 50% flowering. Total length (TL), standard length (SL) and weight of fish were measured weekly up to eight weeks of stocking. Finally total yield of the plots were calculated by measured yield components and the survival rate of the fish was calculated.

Results revealed that fry in the plots had reached a live weight of 2.20 ± 0.86g, TL of 4.5 ± 0.85cm and SL of 3.2 ± 0.33cm which were significantly different (P>0.05) from the control. The survival rate (15%) was low compared to that in control (27%). The paddy yield obtained with normal tillage was 2.2 ± 0.5 t/ha, yield obtained with minimum tillage was 2.1 ± 0.5 t/ha which were not significantly different (Pr> 0.05).

KEY WORDS-Fish, Fry, Integration, Rice

INTRODUCTION

Rice is the staple food of Sri Lanka and most important crop in the country. Due to low and stagnant yield, escalating production costs and diminishing profitability, most of the farmers are ready to give up cultivation of rice (Weerakoon & Athula,2005).Under this situation farmers have faced difficulties and are moving towards alternative income sources. Some farmers in dry zone have converted their paddy plots to fish ponds and grow ornamental fish. Farmers in Polonnaruwa and Minneriya area have already started this in large scale. Although the income has increased it has affected the acreage of paddy and the paddy yield (Jayaweera, 2004). Therefore, rice fish integration can be recommended as a sustainable mean of diversification of paddy farming.

Rice fish integration had been a traditional way of fish culture in some Asian countries. The vast changes brought about with the green revolution drastically affected this low input integrated system. However, the advantages of integration are being realized once again specially in the south Asian countries (Won, *etal.*, 1992). The rice fish integrated farming system is rapidly developing and is popular in many developing countries of the world. The pond refuge system is found in China, Indonesia and Thailand.

Rice fish integration is not a traditional fish culture practice in Sri Lanka. The potential for paddy-fish integration in Sri Lanka is very high (De Silva & Amarasinghe, 1992). Total arable paddy land area of 0.983 million hectares are cultivated and harvested in Yala and Maha seasons (Central bank, 2004). About 45% of paddy lands are located in wet and intermediate zone where irrigation or rain water is available year-round. These paddy lands have the potential to be integrated with fish.

Fingerling production of *Oreochromis niloticus* under paddy fish livestock integration has been successful in Sri Lanka (Edirisinghe, 1992). Exports of aquarium fish by Sri Lanka have been increasing substantially over the past two decades. The value of ornamental fish exports increased from Rs.30 million in 1981 to Rs.370 million by 1997 (Weerakoon,1998). Gold fish is a popular ornamental fish in local & export market. Gold fish production in Sri Lanka has a higher export demand for its superior quality (Export Development Board, 2005).

In Rice fish integration the net cover and side polythin covers are essential protective measures to protect the fish from predators (Jayaweera, 2004). The recommended normal tillage practices are difficult to be applied on the paddy fields with those protective measures. Cost for the tillage practices is about 13%-16% from the total production cost (Anon, 2003) and to reduce the tillage cost alternatives should be applied. To reduce the tillage cost and to cut down pre-planting time period it is better to go for minimum tillage practices. Therefore, identification of the effect of the minimum tillage to the performance of the rice-fish system and economics of the integration is worthwhile.

METERIALS AND METHODS

Experiment was conducted at University of Peradeniya (Mid-Country Wet zone, WM2B) during Yala and Maha seasons in 2004-2005. Six paddy plots of 49m^2 each including a pond refuge of 1m^2 at the centre were used for the experiment. Normal land preparation methods as recommended by the Department of Agriculture were applied for three

randomly selected plots and minimum tillage practices were applied for the other rice plots. In minimum tillage treatment only one ploughing and leveling was applied and, two weeks after that seedlings were transplanted. Air dried poultry manure was applied at the rate of 1000 kg/ha as basal fertilizer (Edirisinghe, 1996). Seedlings of paddy variety BG300 were transplanted at 8cm x 8cm spacing, in all six plots. Four randomly selected plots were fixed with protective cover. Sides of paddy plots were covered up to 1m height with black polythene from the bottom. The rest of the sides up to 2m above ground and the top were covered with 2.5cm gill nets and cover was maintained from the time of transplanting to the end of cultivation season. Other two paddy plots were kept open as the control paddy plot. All pond refuges were fully drained, de-silted and bleached to eradicate all forms of predators following final land preparation and before transplanting. Paddy plots were irrigated with water supply from the adjoining fish pond. Inflow of water was diverted through a mesh (2mm) type water filter to prevent entry of predatory fish.

Goldfish PL obtained from the same parent fish were raised in indoor tanks to produce the required stock of four week old fry which were 1.7 ± 0.12cm in TL and 1.4 ± 0.05cm in SL. They were daily fed with Artemia up to four weeks and weaned to a formulated ornamental fish feed .

Two indoor tanks with a dimension of 0.5m x 1m x 0.5m (2/3 capacity of 250 l of water) were used for the control. Indoor tanks were covered with fish nets to prevent predation of fish by birds and filled with de-chlorinated water and stocked with fry of four weeks of age at 40 per tank (80 fry/m^2) as controls and were daily fed with Artemia .Four paddy plots were stocked with goldfish fry at the rate of 80 fry/m^2 (16000 fry/ha) two weeks after transplanting. Poultry litter was applied at 400 kg/ha weekly for eight weeks as the top dressing starting from two weeks after transplanting (Edirisinghe,1996). Hand weeding was practiced at four weeks. Chemical fertilizers were not used, Pesticides were used to control paddy bug (*Leptocorisa acuta*). Integrated Pest Management technique (IPM) was adopted to keep pest attacks under control (Dayananda, 2004). Water level was maintained at of 2.5-4cm in paddy plots up to two weeks before intended harvesting day. Physico chemical parameters of water in the paddy culture plots and glass tanks were monitored weekly. A sample of six fish was caught from each pond refuge and each glass tank at biweekly intervals for measurements of TL, SL, body depth, weight and colour. PL was measured at the stocking for TL and at the harvesting for TL, SL, body depth, weight and colour. Eight weeks after stocking fish were collected by netting and reducing water level and the total numbers were taken. Percentage survival was calculated. Paddy harvest in each plot was measured. Data on morphology of fish were statistically analyzed by pooled t-test.

After 2 weeks of crop establishment growth parameters of the paddy plants were recorded weekly up to 50% flowering. Root, stem, and leaf dry weights and fresh weights, weed densities were recorded at 50% flowering. At harvesting, total yield of the plots were calculated by using measured yield components. Finally, data were statistically analyzed by Pooled t-test.

RESULTS AND DISCUSSION

1. Analysis of yield components

According to the results of pooled t-test analysis, number of panicles/m^2, number of grains/ panicle, filled spikelets% and thousand grain weight were not significantly different (pr>0.05) in minimum tillage and normal tillage treatments.

2. Yield

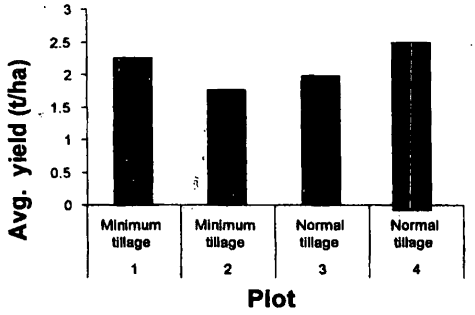

Figure 01.Average yield of paddy plants.

According to Figure 01 yield differences were not significant among normal tillage and minimum tillage treatments.

During the study period, Paddy plants were attacked by paddy bug (*Leptocorisa acuta*), leaf roller (*Cnaphalocrocis medinalis Guen.*), and Plant hopper (*Nilaparvata lugens*) during 50% flowering due to that low average yield was recorded than the standard average yield (4.8 t/ha-5.76 t/ha).

3. Analysis of growth parameters

Tillering pattern and growth pattern of paddy plants

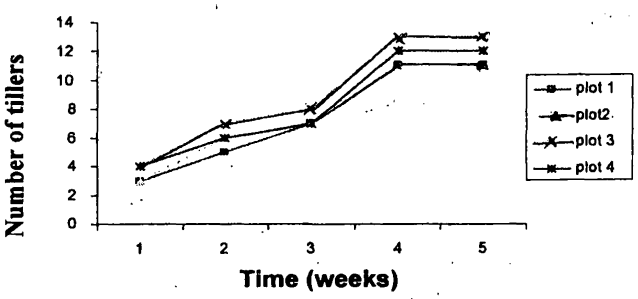

Figure 02.Tillering pattern of paddy plants.

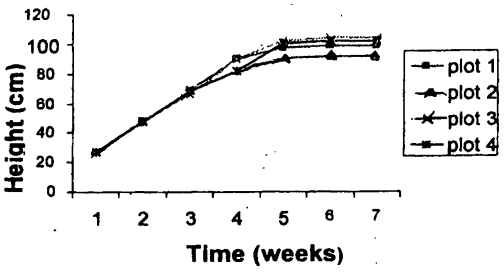

Figure 03.Growth pattern of paddy plants.

Tillering ability is one of the most important traits of rice, which can have significant influence on production of panicles (Miller *et al.*,1991).According to the Figure 02 and Figure 03, the tillering pattern and the growth pattern of paddy plants were not significantly different.(Pr>0.05) in two treatments.

Stem dry weight

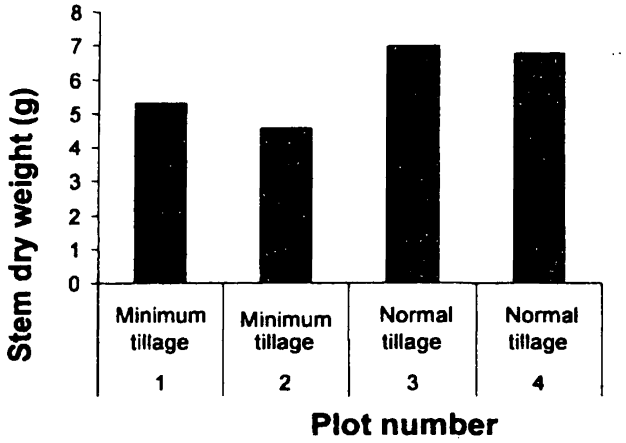

Figure 04. Stem dry weight at 50% flowering.

According to the figure 04 stem dry weight at 50% flowering among minimum tillage and normal tillage were significantly different.

Under normal tillage practices the soil micro environmental condition was better. As a result, the root growth and development was better and dry matter accumulation was better. Therefore, stem dry weight at flowering was higher under normal tillage treatment.

Root dry weight

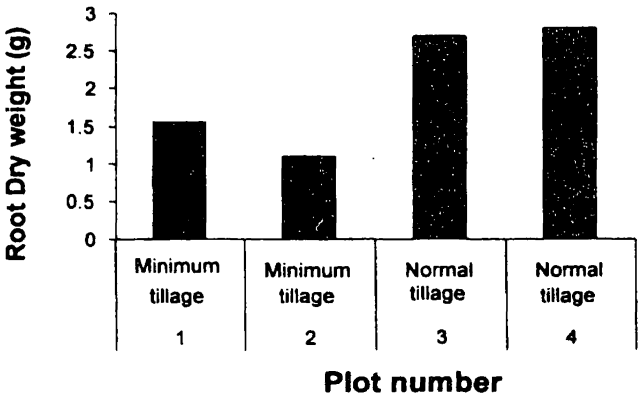

Figure 05.Root dry weight at 50% flowering.

According to the Figure 05 root dry weight at 50% flowering was significantly different among normal tillage treatment and minimum tillage treatment.

Root dry weight resulted from the normal tillage treatment applied plots were higher than the root dry weight resulted from the minimum tillage treatment applied plots.

According to figure 06, leaf dry weights were not significantly different under normal tillage and minimum tillage treatments

Leaf dry weight

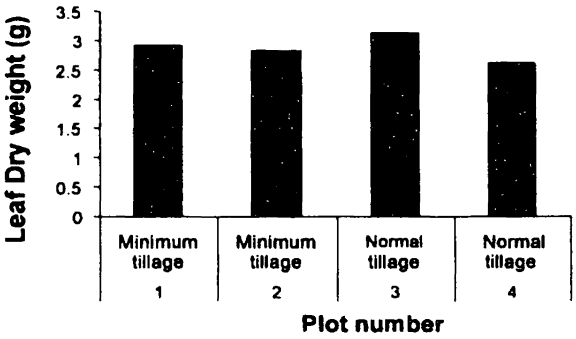

Figure 06.Leaf dry weight at 50% flowering.

4. Analysis of weed densities

Table 01. Weed density at 50% flowering.

Plot no	Tillage method	Weed density Plants/m^2)
1	Minimum tillage	28
2	Minimum tillage	35
3	Normal tillage	8
4	Normal tillage	7

The weed densities of normal tillage treatment applied plots and minimum tillage treatment applied plots were significantly different ($p<0.05$). As the survival rate of the weed seeds were high in the minimum tillage treatment applied plots, recorded weed density was high when compared to the normal tillage treatment applied plots. Therefore, frequent weeding should be applied to maintain the weed density at a lower level. When considering the weed type more number of broad leaves were recorded than grass.

5. Analysis of growth parameter of fish

Observation made in all four plots before stocking of fish revealed that plots and pond refuges were free from wild fish. Though predatory fish were not found in pond refuges during the period of study, backswimmer (*Anisops spp.*) and dragonfly larvae (*Pantala spp*) were found in the plots. Entry of piscivorous birds, crawling animals like water snakes was restricted in these plots with polythene side cover, and top net cover but the entry of crabs and frogs could not be restricted and frogs tadpoles and crabs were found often in paddy plots and pond refuges.

Mosquito larvae were plentiful in all the plots. After fish introduction their population was eliminated. As goldfish are omnivores they eat plants, insect such as mosquito larvae, small crustaceans, zooplankton, and detritus.

According to the figure 08.The final TL of fish in paddy plots and the control were significantly different ($p<0.05$). Fish in paddy plots have reached TL of 3.2 ± 0.4cm at harvesting. In addition, fish in paddy plots had reached marketable body length (SL of 3.0cm-5.0cm) within 6 to 8 weeks.SL of fish in the control with no aeration had not reached marketable size at harvesting. While 62% of the fish produced in

paddy plots had recorded TL over 5cm at harvesting. Therefore, the required lengths of fish can be obtained with in 6-7 weeks from paddy plots. That is a shorter time period when compared to the control. Body lengths were not significantly different among normal tillage and minimum tillage treatments.

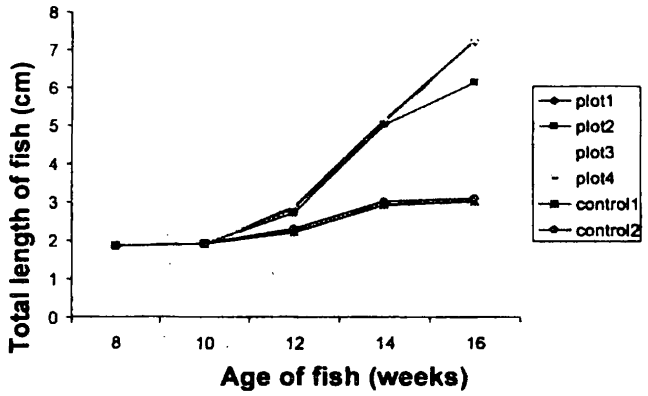

Figure 08.Increase in total length (TL) of fish fry in paddy plots and in the control.

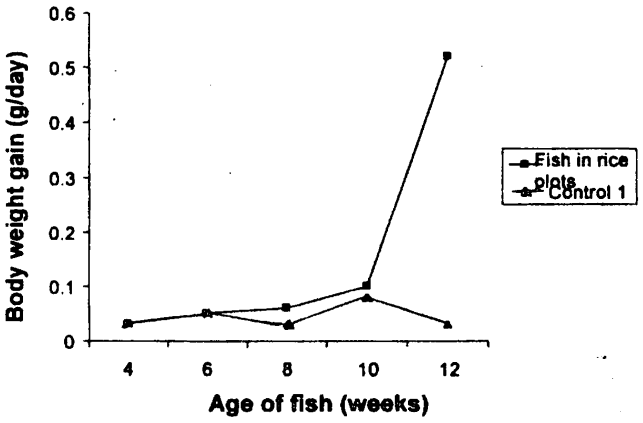

Figure 09.Growth of fish in eight weeks culture cycle.

According to the Figure 09.The rate of growth of fish in terms of body weight gain had a significant difference ($p>0.05$) from the fourth week of stocking up to the end of culture cycle (Figure 09). Poultry litter that used in the experiment as the organic manure would have served duel role as a major source of feedstuffs for fish and nutrient source for growth of plankton. Due to the application of poultry manure the Plankton density have increased during 8-10 weeks. So the available feed for the fish is high during that period. Therefore, a rapid increase in the body weight gain of the fish in the rice plots was observed. Recorded body weights were not significantly different among normal tillage treatment and minimum tillage treatment.

CONCLUSIONS

Results of the study demonstrate that there isn't any effect of minimum tillage for the growth of paddy plants, to the productivity of the paddy plant and to the final yield. But due to high weed density in the minimum tillage treatment applied plots frequent weeding had to be done. Therefore, additional cost has to be spent. But when compared the total costs of two treatments, significant difference could not be observed. Therefore, minimum tillage practices will be an easy, convenient and low cost method that is compatible with rice fish integration. The average yield in this experiment was 2.5 t/ha. It was significantly lower than the average yield recorded in Sri Lanka under this variety. By the obtained results about goldfish fry, it can be raised in paddy plots to produce fish with a total length of 7.5cm in eight-week culture period and 3.0-50cm can be achieved in 6 weeks. Gold fish Production can be done starting from four-week old fry, using poultry litter as the sole fertilizer. Higher percentage of bright coloured goldfish can be obtained by stocking goldfish in paddy fish integration.

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